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Gut Content Analysis of Selected Commercially Important Species of Coral Reef Fish in the Southwest Part of Iligan Bay, Northern Mindanao, Philippines

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Abstract The diet composition of selected economically important reef fishes was described. Sampling for fish and plankton was done every month from July to December 2004 in eight sampling stations located in Maigo and Kauswagan, lanao del Norte. Nine fish species were selected for the gut content study. The nine species belong to seven families: the Gerreidae (*Gerres oyena*), Leiognathidae (*Leiognathus splendens*), Lethrinidae (*Lethrinus insulindicus*), Scaridae (*Scarus bowersi*), Siganidae (*Siganus guttatus* and *Siganus vermiculatus*), Theraponidae (*Therapon jarbua* and *Therapon* sp.) and Mullidae (*Upeneus caeruleus*). The result of the stomach or gut content analysis showed that majority of the fish species preyed on zooplankton and benthic animals. These fishes were categorized as generalist species based on Costello's method. They are represented by *Gerres oyena, Leiognathaus splendens, Lethrinus insulindicus, Therapon jarbua, Therapon* sp. and *Upeneus caeruleus* except for fishes belonging to Family Scaridae (*Scarus bowersi*) and Family Siganidae (*Siganus guttatus* and *Siganus vermiculatus*) which exclusively fed on algae and were categorized as strict herbivores. A total of 46 zooplankton groups were identified and 76.51% of the total population was composed of copepods which included calanoida, cyclopoida, harpacticoida, copepod nauplius and eggs. Comparison between the abundance of zooplankton between stations in Maigo, and Kauswagan, Lanao del Norte showed no significant difference ($p > 0.05$) in both areas. This study showed that out of the nine economically important reef fishes, six fish species preferred to prey on zooplankton species. This further showed that despite the abundance of zooplankton in the environment, planktivorous fishes preferred to prey on some zooplankton groups like copepods, amphipods and crab megalopa. Hence, zooplankton as prey of selected economically important reef fishes should be conserved and harvesting of commercial fishes should be controlled.

Key words: Reef Fishes, Diet, Zooplankton, Costello's method, Electivity Index, Iligan bay

Introduction

The Philippines, Indonesia, Papua New Guinea and Borneo form the Southeast Asia's "Coral Triangle" where the largest coral reef diversity in the world is found (McManus, 1988). Particularly in the Philippines, almost 400 of the reef building species are identified, of which, 12 species are endemic. In addition to this are the presence of 500 species of clams, snails and other mollusks (Springteen and Leobrera, 1986), 981 species of bottom algae (Silva et al., 1987) and most importantly 2,500 species of fish (Herre, 1953). Over the last two decades, the reef and reef associated fish has been the subject of major investigations in the country. Many of these studies focused on questions that are highly relevant to the better understanding of biodiversity and conservation among others. Hilomen et al., (2000) estimated the total number of reef and reef-associated fish worldwide. The diversity of reef fish forms a part of the country's genetic, morphological and functional diversity (Ong et al., 2002). At the regional scale, geographic origin is more important. Alino et al., (1994) classified reef fish habitat into six biogeographic zones, namely, Northeastern Philippines Sea region, Visayas region, Southeastern Philippines Sea Region, South China Sea region, Sulu Sea region and Celebes Sea region. The highest diversity was observed in Sulu Sea followed by South China Sea and Celebes Sea. The poorest species diversity is found in the Southeastern Philippines sea region. The high diversity of coral reef fishes is maintained by the complexity of coral reef areas that provide different ways for fishes to feed, live and reproduce. Coral reef fishes are of great interest because of its immense value to mankind especially that these animals are part of the daily diet of the Filipino people. It would be more interesting if feeding diets of these amazing creatures will be given importance, thereby, increasing their productivity. In particular, the potential role as food and abundance of zooplankton communities will further gear the assessment of the potential productivity of the bay's fishing grounds.

This study aims to identify some economically important reef fishes to the lowest taxon possible; to determine the composition and abundance of the natural prey population such as zooplankton in the reef areas; to identify the food or prey items in the stomach or gut of these reef fishes; to determine the frequency of occurrence, percentage and ranking index of prey items in the diet of reef fishes; to determine the prey importance between the abundance of prey items within the diet of the fish and the natural zooplankton population in the reef areas.

Material and Methods

Study Areas and Sampling Stations

Maigo covers an area of approximately 12,130 hectares along the coast of Panguil Bay with geographical grid coordinates of 8°10' North Latitude and 124° East Longitude. Kauswagan is sprawled along the coast of Iligan Bay with a geographical grid coordinates of 124°5' East Longitude and 8°12'15" North Latitude. For the procurement of reef fishes from the fishermen, eight barangays were designated as fish landing centers. These centers were Kulasihan, Segapod, Labu-Ay and CMR in Maigo, Lanao del Norte and Poblacion, Dalikanan, Libertad and Tacub in Kauswagan, Lanao del Norte (Fig. 1). The locations of the stations were established using a GPS (Garmin GPSMAP 76S).

Collection of Fish Samples

Five to 20 individuals of each economically important reef fish taxon available in each designated

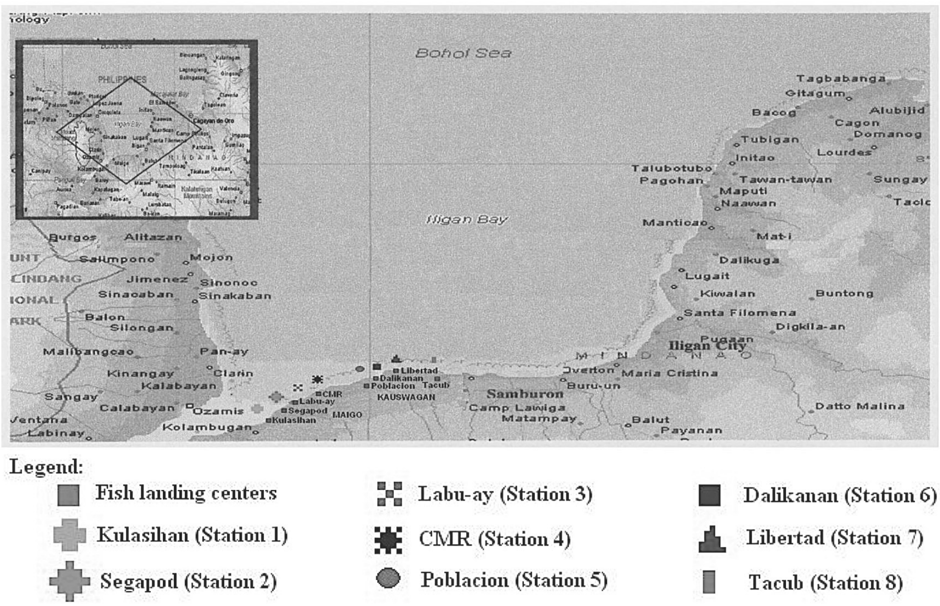

Fig. 1. Map of Iligan Bay showing the fish landing centers and sampling stations for zooplankton collection. Inset is the map of Mindanao with Iligan Bay enclosed in a diamond.

sampling stations were collected from the fishermen who went fishing together with the researcher. Fish individuals per taxon were labeled with its local name, the name of sampling station and the date of collection. Each labeled fish were placed in the cellophane. All fish collected was placed in an icebox half-filled with ice in order to preserve their gut. Collection of fish samples in each sampling stations was done 3 or 4 times a month in order to attain the prescribed number of individuals. Only reef fishes that were caught at nighttime and those collected in the reef areas of Maigo and Kauswagan were used in the study. Collection of reef fishes was done monthly during full moon for a period of six months.

Identification and Photo documentation of Fish Samples

After the field collection, photo documentation of each fish was done using a digital camera (Kodak EASYSHARE). The fish was then identified using the manual of Rau and Rau (1980), and Fishbase Worldwide Web Electronic Publication (www.fishbase.com, Froese and Powly, 2005). Dissection of the gut content was conducted right after the photo documentation.

Gut Content Analysis

Intact stomach was separated from the fish and weighed using a Metler Analytical balance. The weight of the stomach and its contents were recorded. Afterwards, the stomach was dissected and its contents were preserved with 70% ethanol. Then the dissected and empty stomach was weighed again. The difference between the weight of the intact stomach and the weight of the empty stomach was the total weight of stomach contents. The preserved stomach contents were then examined under a stereomicroscope and contents were then enumerated and identified to the lowest taxa possible.

Each prey item was scaled from 0 to 1 using a 0.05 by point method, with the total contents regarded as 1 (Hobson, 1974). The result of this point method was the volumetric scale value of each prey item. Then the weight of each prey item in the stomach of an individual fish sample was determined by multiplying the total weight of stomach content with its volumetric scale.

The food or prey items of each fish taxa were ranked following the formula of Hobson (1974):

$RI = (A/B)\ (C)$

where RI = Ranking Index of each prey item

A = number of fish individuals per taxa containing each prey item

B = total number of fish individual per taxa with stomach content

C = percentage of each prey item which can be computed as:

$$= \frac{\text{Volumetric scale of prey item}}{\text{Volumetric scale of all prey items combined}} \times 100$$

Zooplankton Collections

Zooplankton samples were collected from each station using a conical plankton net (length: 1.8 m, mouth diameter: 0.45 m, mesh size opening: 100 μm with a flowmeter) (Rigosha and Co., Ltd No 1687) attached to the center of the mouth of the net. The flowmeter was used to measure the quantity of the water filtered by the net. The flowmeter has a propeller that rotates with the flow of water and records the number of revolutions. Before zooplankton collections were done, the flowmeter was calibrated first on a calm day following the procedure of Omori and Ikeda (1984). This procedure starts with the flow meter being attached to the mouth frame from which the net has been removed. Then the flowmeter was lowered to a depth of 50 m and slowly hauled to the surface. Immediately the number of revolutions registered in the flowmeter was noted and recorded. This operation was repeated four times and the average value of the number of revolutions was obtained. The calibration constant of the flowmeter is the average value of the number of revolutions.

During collection, the plankton net, with the flowmeter attached to the middle of its mouth, was lowered to a depth of 3-13 m and slowly hauled back to the surface. Zooplankton samples collected at the cod- end of the net was drained into properly labeled polyethylene bottle. Triplicate samples were collected in each sampling stations. Immediately after each zooplankton collection, the samples were fixed with buffered formalin. Preparation of the buffered formalin was done by adding 2 g of borax to 100 ml concentrated formalin at pH 7-8. Based on the volume of the collected zooplankton sample, 5% of the concentrated buffered formalin solution was added. Zooplankton collections were done during nighttime at least once a month for a period of six months. Sampling was done every month during full moon.

Sorting, Identification, and Counting of Zooplankton Samples

In the laboratory, the volume of the whole zooplankton samples were measured, recorded and sorted out in the petri dish. Those zooplankton individuals that are large enough to be seen by the naked eyes were identified, counted and then removed from the whole sample. The removed zooplankton was transferred into a vial half-filled with 70% ethyl alcohol. The preserved zooplankton individuals were used for photo documentation and future reference.

Once all large zooplankton were sorted and counted, the counting of the small zooplankton individuals immediately follows. Using an improvised wide mouth pipette (1.0 ml), a 1-ml subsample was taken from the whole zooplankton sample. The subsample was then placed into a Sedgewick-rafter counting chamber cell (depth: 1 mm, length: 50 mm, width: 20 mm, area: 1000 m, volume: 1 ml) and was covered with a coverslip in a manner where no bubbles were formed inside the chamber. The counting chamber was then viewed under a dissecting microscope (Carton TB-20) and each zooplankton individuals were identified, counted and recorded in a tally sheet. This method of counting was repeated several times until each major zooplankton representatives reaches at least 300 individuals.

The abundance of each zooplankton taxa, expressed as individuals m^{-3} was calculated using the following formula (Harris et al., 2000):

$$\text{individuals } m^{-3} = \frac{nK}{m^3}$$

where n = total number of individuals
K = part of the sample counted, i.e., the proportion of the total volume sample to the volume of all samples
m = volume of the water filtered by the net
$= B \times M \times C$
where B = actual flowmeter reading during zooplankton collections
M = area of the mouth of the net
C = approximately 20 meters deep of the net hauled over the calibration constant of the flowmeter

Identification and Documentation of the Zooplankton Specimens

The zooplankton individuals were identified using the illustration and guide manuals of Newell and Newell (1963), Yamaji (1982), Todd and Laverack (1991) and Boltovsky (1999). A whole mount of each taxon was prepared for photodocumentation using the photomicrograph systems (Zeiss).

Data Analysis

One-way analysis of variance (ANOVA) was used to test the difference in zooplankton abundance between sampling stations and the spatial variations of prey items in the diet of reef fishes. Pearson Product Moment Correlation was used to test the correlation between the prey items within the diet of the fish and the abundance of the natural zooplankton prey population in the reef areas.

Costello's Method

The Costello's method (1990), which is a graphical representation of prey items, was used to determine whether the fish species is a generalists or specialists (Lima-Junior, 2001). The method consists of a scatter plot of percentage volume values in the y axis and frequency of occurrence in the x axis. Points located near 1% of occurrence and 1% of volume showed that the predator consumed different preys in low quantity, a hypothetical example of a trophic generalist species. On the other hand, points located near 100% of occurrence and 100% volume show that the predator is a specialists for a given prey. The Costello method uses information on the abundance based on volumetric values and frequency of occurrence of the prey items in the gut of fish species. Hence, in this study the prey items in the diet of the fish species were plotted in a graph so as to determine whether the fish in this study is a generalists or specialists (Amundsen et al., 1996).

Results and Discussion

This study dealt with the identification of the diet composition of coral reef fishes collected from Maigo and Kauswagan, Lanao del Norte from July to December 2004. There were nine fish species belonging to seven families: Gerreidae (*Gerres oyena*), Leiognathidae (*Leiognathus splendens*), Lethrinidae (*Lethrinus insulindicus*), Scaridae (*Scarus bowersi*) Siganidae (*Siganus guttatus* and *Siganus vermiculatus*), Theraponidae (*Therapon jarbua* and *Therapon* sp.) and Mullidae (*Upeneus caeruleus*).

Results of this study showed a diverse and abundant zooplankton community and a diverse group of reef fishes. There were 45 species of zooplankters identified and were grouped into eight major zooplankton groups. The zooplankton groups encountered in eight stations were Cnidaria, Annelida, Chaetognatha, Protochordata, Arthropoda, Echinodermata, Mollusca and Chordata. From these eight groups, a total of 45 zooplankters were encountered in both areas. Therefore, it can be inferred that this coastal waters of the southeast part of Iligan Bay is an environment where food is not a stress factor. Comparison of the relative abundance of zooplankton between stations in Maigo and Kauswagan, Lanao del Norte showed no marked differences ($p > 0.05$, One-way ANOVA). The most abundant zooplankton group sampled from Maigo, Lanao del Norte were the copepod (including calanoida, cyclopoida, harpacticoida, copepod nauplius and eggs). The copepod comprised about 76.51% of the total population. The second most abundant group was the non-crustacean zooplankton (such as cnidaria, annelida, chaetognatha, protochordata and echinodermata) with 13.80% of the entire population and the other crustacean groups (4.62%: amphipoda, ostracoda, cumacea, isopod, euphausiid, mysid, lucifer and decapoda). The least abundant group was the fish (0.28%). A similar result was observed in Kauswagan, Lanao del Norte where copepods comprised 77.33% of the bulk of the whole sample. The second most abundant group was the non-crustacean zooplankton (18.57%) and other crustacean groups (2.23%). The least abundant group was the fish (0.39%).

Majority of the zooplankters belong to subclass copepoda which prove that copepods is one of the most dominant groups of zooplankton and constitutes the bulk of the net plankton (Bougis, 1976; Castro and Huber, 1997). This is in concordance with other studies (Johannes and Geber, 1974; Moore and Sander, 1976; Ferraris, 1982; Vassire and Segiun, 1984) that copepods are the dominant organisms and are ecologically the most important crustacean in that they are the major herbivores, grazing on the phytoplankton and forming the basis of most food chain in the sea.

The food of Coral Reef fishes were varied and diversified to include polychaetes, mollusks juveniles, crustaceans, fish larvae and eggs and various algae. Fishes with longer intestine tended to feed on plant materials while those with short intestines tended to feed on animal materials. Gut content analysis showed that most of the fish species preyed on zooplankton and benthic animals. These fishes were categorized as generalist species based on Costello's method of prey importance. They are represented by *Gerres oyena, Leiognathaus splendens, Lethrinus insulindicus, Therapon* *jarbua, Therapon* sp. and *Upeneus caeruleus* except for fishes belonging to Family Scaridae (*Scarus bowersi*) and Family Siganidae (*Siganus guttatus* and *Siganus vermiculatus*) which exclusively feed on algae and were categorized as strictly herbivores.

Prey items of *Gerres oyena* included the detritus (66.6%) as the dominant prey items in the gut of four fishes, followed in rank by crustacean fragments (50% = 3 fishes), then the fish juvenile and nematode (33.3% = 2 fishes) and lastly, bivalve and gastropod juvenile (16.6% = 1 fish) (Table 1). Despite the frequent occurrence of detritus in the fish gut, this prey item was negligibly small in terms of abundance (1.65%) and even occupied a very low rank (1.10). Nematode likewise was also the least abundant and the lowest in the ranking index. Since both detritus and nematode occupied the lowest rank they were the least preferred prey items of this species. Fish juvenile, mollusks (gastropod and bivalve juvenile) and crab megalopa are recognized as zooplankton while the lesser prey items such as the nematode and shrimp are categorized as benthic animal.

Analysis using Costello's method showed that the points (in symbols) of crustacean fragments, fish juvenile, mollusks (bivalves and gastropod juvenile), nematode and detritus were located below 30% for

Table 1. Prey items of *Gerres oyena*.

Prey Items	Percent of fish containing prey items	Percentage of prey items	Ranking Index
Crustacean fragments	50.0	27.49	13.47
Fish juvenile	33.3	18.15	6.16
Unknown fragments	33.3	17.32	5.77
Bivalve juvenile	16.6	16.50	2.75
Gastropod juvenile	16.6	16.50	2.75
Detritus	66.6	1.65	1.10
Nematode	33.3	2.47	0.82

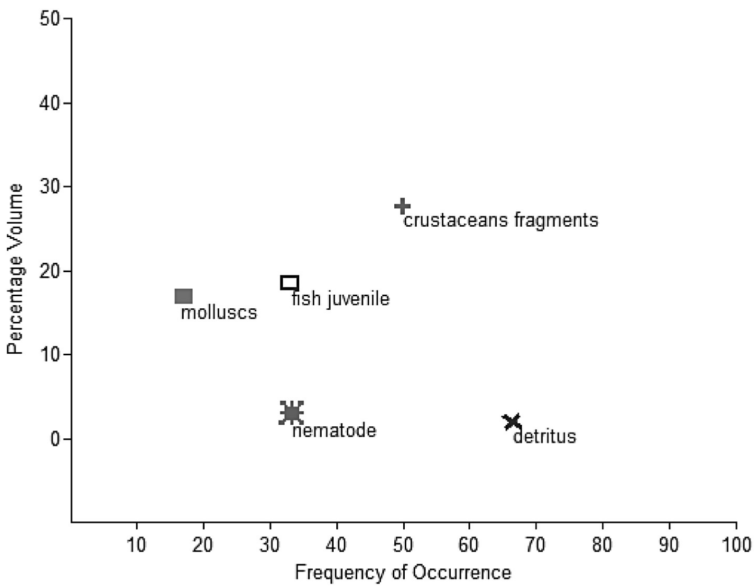

Fig. 2. A graphical representation of the prey items in the gut of *G. oyena* based on Costello's method.

percentage volume while only the point of detritus was plotted above 60% for frequency of occurrence. Most of the prey items had low quantity both in percentage volume and frequency of occurrence. Therefore, *G. oyena* was categorized as generalist based on the Costello's method (Fig. 2).

Frequency of occurrence (Table 2) showed that 40 fish samples of *Leiognathus splendens* took crustacean fragments (76.92%), 32 contained bivalve larvae (61.5%), 24 had eaten gastropod larvae (46.1%), 23 had copepods (44.2%) in their gut and 10 had amphipod (19.2%). Other prey items were the following: sand (42.3% = 22 fishes), shrimp and algae (19.2% = 10 fishes), detritus (17.3% = 9 fishes), crab megalopa, polychaetes, fish juvenile and nematode (7.6% = 4 fishes) and lastly, the cumacea and squid juvenile (1.92% = 1 fish). However, crustacean fragments, crab megalop and cumacea (12.64%) were the most dominant among the prey items. Although they were the dominant prey items, they occupied different ranks: Crustacean fragments (mixture of broken parts of crab megalopa and carapace of shrimp) occupied the first rank (9.95) which meant that they were the most preferred prey item. It is notable that zooplanktonic copepods, bivalve and gastropod juvenile were ranked 2nd (4.06), 3rd (3.71) and 4th (2.12) in the food items, respectively. Sand, detritus, and algae were also recorded from the list of items, however, its percentage were fairly small. Crab megalopa, polychaetes, fish juvenile, cumacea and squid juvenile were categorized as zooplankton. Those items categorized as benthic organisms, such as amphipod, shrimp and nematode, were also observed but were not dominant (Table 2).

In contrast, the points (in symbols) for amphipod, shrimp, (sand), crab megalopa, algae, detritus, polychaetes, fish juvenile, cumacea, nematode, squid juvenile and gastropod juvenile were located below 20% for percentage volume indicating that these prey items obtained low quantity in terms of abundance while the points for bivalve juvenile and crustacean fragments were located above 60% and 70%, respectively, of frequency of occurrence. Despite the frequent occurrence of bivalve juvenile and crustacean fragments among the other prey items, the result suggests that *Leiognathus splendens* is a generalists based on Costello's method (Fig. 3).

Frequency of occurrence (Table 3) showed that crustacean fragments (61.1%) were the dominant prey items in the gut of 22 fishes, followed by crab megalopa and shrimp (30.6% =11 fishes), then fish

Table 2. Prey items of *Leiognathus splendens*

Prey Items	Percent of fish containing item	Percentage of prey items	Ranking Index
Crustacean fragments	76.92	12.93	9.95
Copepod	44.23	9.19	4.06
Bivalve juvenile	61.54	6.03	3.71
Gastropod juvenile	46.15	4.59	2.12
Unknown fragments	36.54	4.02	1.47
Amphipod	19.23	6.61	1.27
Shrimp	19.23	6.61	1.27
(Sand)	42.31	2.87	1.21
Crab megalopa	7.69	12.64	0.97
Algae	19.23	4.31	0.83
Detritus	17.31	2.59	0.45
Polychaetes	7.69	5.46	0.42
Fish juvenile	7.69	4.02	0.31
Cumacea	1.92	12.93	0.25
Nematode	7.69	2.29	0.18
Squid juvenile	1.92	2.87	0.06

juvenile (22.2% = 8 fishes) and then brittle star (16.7% = 6 fishes). Other prey items observed in the diet of *L. insulindicus* were the following: amphipod, (sand), and detritus (8.3% = 3 fishes), gastropod juvenile (2.8% = 1 fish) and then polychaete and squid juvenile (2.7% = 1 fishes). However, fish juvenile (22.64%) was the most dominant prey item. This was followed by crab megalopa (16.33%), brittle star (15.19%), crustacean fragments (14.89%) and then shrimp (12.32%). Crustacean fragments included broken parts of crab megalopa and shrimp. Crab megalopa, fish juvenile, brittle star, gastropod juvenile, polychaete and squid juvenile were categorized as zooplankton while shrimp and amphipod were categorized as benthic animal. Sand and detritus were also noted. The presence of detritus indicated that *L. insulindicus* fed on dead organic matter.

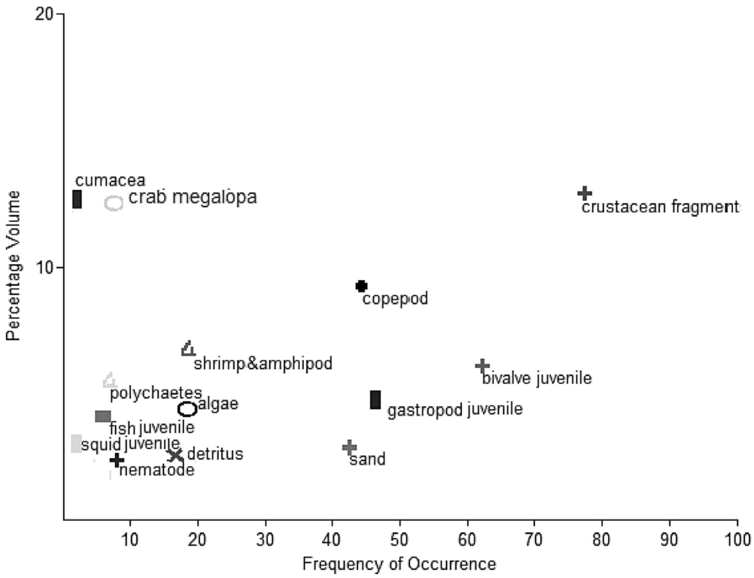

Fig. 3. Graphical representation of the prey items in the gut of *Leiognathus splendens* based on Costello's method.

Table 3. Prey items of *Lethrinus insulindicus*

Prey Items	Percent of fish containing items	Percentage of prey items	Ranking Index
Crustacean fragment	61.1	14.89	9.09
Fish juvenile	22.2	22.64	5.03
Crab megalopa	30.6	16.33	4.99
Shrimp	30.6	12.32	3.76
Brittle star	16.7	15.19	2.53
Unknown fragments	25.0	4.29	1.07
Amphipod	8.3	3.43	0.28
(Sand)	8.3	2.87	0.24
Detritus	8.3	2.29	0.19
Gastropod juvenile	2.8	2.87	0.08
Polychaetes	2.7	1.15	0.03
Squid juveniles	2.7	1.15	0.03

The points (in symbol) of most of the prey items of *L. insulindicus* were located below 30% of percentage volume and only crustacean fragments had a point located above 60% percent of frequency of occurrence. Since most of the prey items had low quantity in terms of percentage volume and frequency of occurrence. *Lethrinus insulindicus* is classified as a generalist based on Costello's method (Fig. 4).

Forty-three adult fish samples of *Therapon jarbua* were collected, 18 of which had stomach contents. Frequency of occurrence presented in Table 4 showed that six contained copepod (33.33%), five had eaten fish juveniles and five had crustacean fragments (27.78%) in their gut. Other prey items were the following: nematode (22.2% = 4 fishes), gastropod juvenile (27.7% = 5 fishes), amphipod,

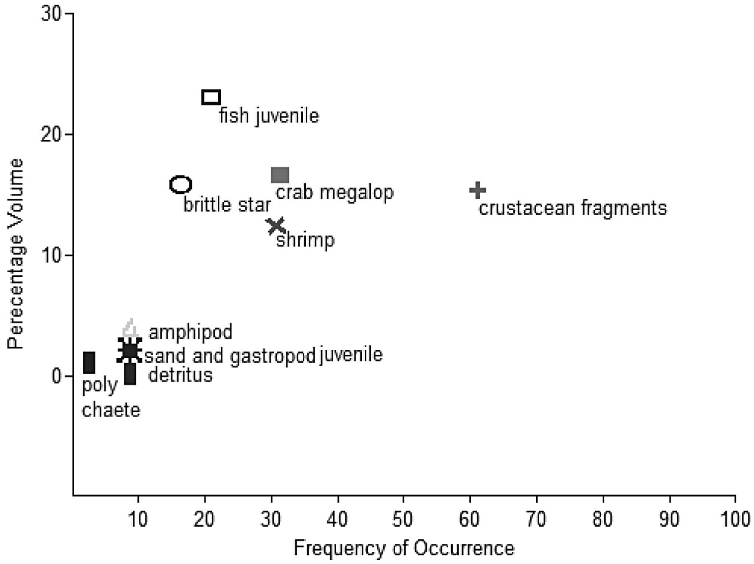

Fig. 4. Graphical representation of prey items in the gut of *Lethrinus insulindicus* based on Costello's method.

Table 4. Prey items of *Therapon jarbua* collected from Maigo, Lanao del Norte.

Prey Items	Percent of fish containing items	Percentage of prey items	Ranking Index
Fish juvenile	27.78	26.84	7.46
Copepod	33.33	21.75	7.25
Crustacean fragments	27.78	16.67	4.63
Unknown fragments	38.89	3.11	1.21
Nematode	22.22	15.25	1.17
Gastropod juvenile	27.78	3.11	0.86
Amphipod	11.11	3.67	0.41
Bivalve juvenile	11.11	3.67	0.41
Cumacea	11.11	2.82	0.31
Shrimp	11.11	1.41	0.16
Detritus	5.56	1.12	0.08

bivalve juvenile, cumacea, shrimp (11.1% = 2 fishes) and then detritus (5.5% = 1 fish). However, fish juvenile (26.84%) was the most dominant among the identified prey items. This was followed by copepod (21.75%), crustacean fragments (16.67%), and nematode (15.25%). Fish juvenile, copepod, crustacean fragments (broken parts of crab megalopa), mollusks (gastropod and bivalve juvenile) and cumacea were categorized as zooplankton while nematode, shrimp and amphipod were categorized as benthic animals. Detritus (1.12%) was also noted but it was less dominant in terms of abundance and even occupied the lowest rank (0.08) which meant that it was the least preferred prey item of this species.

The points (in symbols) of fish juvenile, copepod, crustacean fragments, nematode, gastropod juvenile, amphipod, bivalve juvenile, cumacea, shrimp and detritus were plotted below 30% of percentage volume and frequency of occurrence. The results showed that *T. jarbua* is a generalists

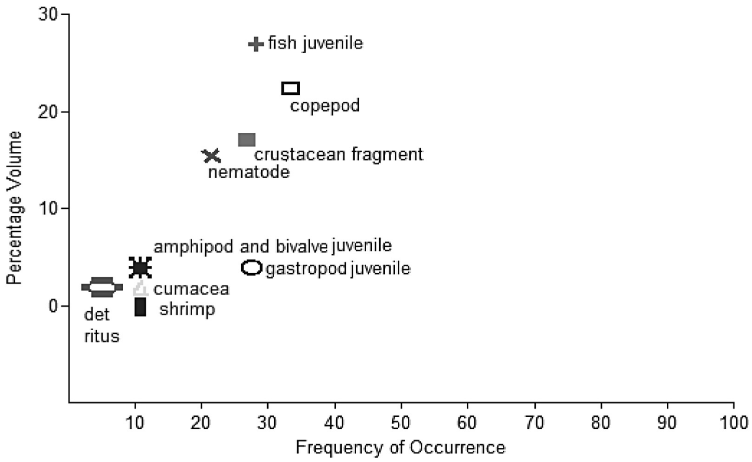

Fig. 5. Graphical representation of prey items in the gut of *Therapon jarbua* based on Costello's method.

Table 5. Prey items of *Therapon* sp.

Prey items	Percent of fish containing items	Percentage of prey items	Ranking Index
Bivalve juvenile	69.23	6.59	4.56
Copepod	53.85	7.14	3.84
Gastropod juvenile	61.54	5.77	3.55
Shrimp	11.54	25.27	2.91
Unknown fragments	30.77	8.52	2.62
Amphipod	30.77	7.96	2.45
Crustacean fragments	42.31	4.95	2.09
Fish juvenile	7.69	14.56	1.12
Nematode	42.31	1.63	0.69
Detritus	11.54	5.49	0.63
(Sand)	11.54	5.49	0.63
Tanaid	26.92	1.67	0.44
Cumacea	26.92	1.37	0.37
Brittle star	7.69	2.19	0.17

based on the Costello's method (Fig. 5).

Forty-eight fish samples of *Therapon* sp. were collected, 26 had food items in their stomachs. For the frequency of occurrence (Table 5), 18 took bivalve juvenile (69.2%), 16 had gastropod juvenile (61.5%), and 14 had copepod (53.8%). Other prey items identified were following: crustacean fragments and nematode (42.3% =11 fishes), amphipod (30.7% = 8 fishes), tanaid and cumacea (26.9% = 7 fishes), fish juvenile and brittle star (7.6% = 2 fishes) and shrimp (11.54% = 3 fishes). Despite the frequent occurrence of bivalve juvenile (69.2%), it occupied only 6.59% in terms of percentage weight compared with fish juvenile which had 14.56%. Although bivalve juvenile obtained low percentage value, it occupied the highest rank (4.56) which meant that bivalves were their preferred prey item.

Graphical illustration showed that the points (in symbol) of bivalve juvenile, copepod, gastropod juvenile, shrimp, amphipod, crustacean fragments, fish juvenile nematode detritus, (sand), tanaid, cumacea and brittle star were all plotted below 30% of percentage volume while points of bivalve juvenile and gastropod juvenile were plotted above 60% of frequency of occurrence. Despite the fact that bivalve and gastropod juvenile were located near 100%, most of the identified prey items obtained low percentage volume and frequency of occurrence, thus, *Therapon* sp. is a generalists based on the

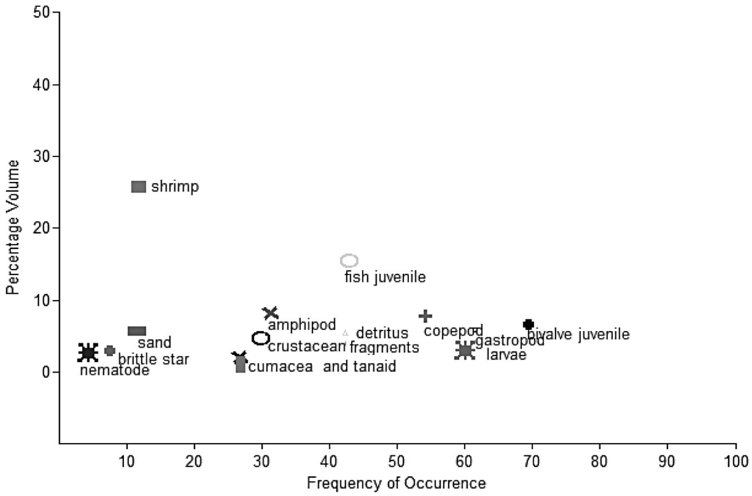

Fig. 6. Graphical representation of prey items in the gut of *Therapon* sp. based on Costello's method.

Table 6. Prey items of *Upeneus caeruleus*.

Prey Items	Percent of fish containing items	Percentage of prey items	Ranking Index
Crustacean fragments	75.0	21.32	15.99
Shrimp	50.0	13.18	6.59
Nematode	50.0	11.24	5.62
Crab megalopa	25.0	19.38	4.85
Gastropod larvae	25.0	11.63	2.91
Unknown fragments	12.5	19.38	2.42
Amphipod	12.5	1.94	0.24
Detritus	12.5	1.94	0.24

Costello's method (Fig. 6).

Twenty-two adult fish samples of *Upeneus caeruleus* were collected and examined, of which eight had food contents in their stomachs. As presented in Table 6, crustacean fragments (75%) were the dominant prey item of six fish samples, followed by shrimp and nematode (50% = 4 fishes), then by crab megalopa and gastropod juvenile (25% = 2 fishes) and lastly by amphipod and detritus (12.5% = 1 fish). Among the prey items, crustacean fragments (21.32%) were the most dominant in terms of weight percentage and occupied the first rank (15.99). This was followed by crab megalopa (19.38%) even though it occupies the fourth rank (4.85), then shrimp (13.18%) and nematode (11.24%). Amphipod and detritus (1.94%) were also observed but were less dominant and occupied the lowest rank (0.24). Crustacean fragments, crab megalopa and gastropod juvenile were categorized as zooplankton while shrimp, nematode and amhipod were recognized as benthic animals.

Costello's method showed that the points of crustacean fragments, shrimp, nematode, crab megalopa, gastropod juvenile, amphipod and detritus were plotted below 30% of the percentage volume while the points of crustacean fragments, shrimp, and nematode were plotted above 40% of frequency of occurrence. Majority of the prey items had low quantity both in percentage value and frequency of occurrence, hence, *Upeneus caeruleus* is a generalist species based on the Costello's method (Fig. 7).

The presence of detritus suggested that this fish species fed on dead organic matter. Moreover, a report on the diet of *U. tragula* collected at Ryuku Islands stated that it preyed mostly on decapods (Yamashita et al., 1985). This prey item was categorized as zooplankton.

Seventeen and seventy-nine fish samples of *Scarus bowersi* were collected from Maigo and Kauswagan, Lanao del Norte respectively. Stomach content analysis showed that algae were exc1usively the dominant food items observed in their stomachs.

Fifteen and forty-four specimens of *Siganus vermiculatus* were collected from Maigo and Kauswagan, Lanao del Norte, respectively. Their diet was dominated by algae.

Thirty-eight and twenty-two fish samples of *Siganus guttatus* were collected from Maigo and Kauswagan, Lanao del Norte, respectively. Algae constituted the major food item of this species. Based on the results, *Scarus bowersi, Siganus vermiculatus* and *Siganus guttatus* are strictly herbivores.

Table 7 shows the summary of the classification of food habits of each coral reef fishes. Results of gut content analysis showed that some of the economically important reef fishes fed on zooplankton and benthic animal. Hence, they were categorized as generalists species based on Costello's method. The prey items observed in the gut of the fishes composed of zooplankters such as copepod, fish juvenile, bivalve juvenile, gastropod juvenile, crab megalopa, and polychaetes. Crustacean fragments and detritus were also observed. Crustacean fragments included broken parts of crab megalopa and carapace of shrimp. The presence of detritus suggested that some fish species fed on decomposed organic debris, small pieces of dead and decomposed plants and animals. However, *Scarus bowersi, Siganus guttatus* and *Siganus vermiculatus* were strictly herbivores which fed mainly on algae.

Prey items observed in the diet of the most reef fishes, specifically *Gerres oyena, Leiognathus splendens, Lethrinus insulindicus, Therapon jarbua, Therapon* sp. and *Upeneus caeruleus*, were mostly dominated by zooplankton organisms. On the other hand, the Family Scaridae (*Scarus bowersi*) and Family Siganidae (*Siganus guttatus* and *Siganus vermiculatus*) exclusively fed on algae. Benthic organisms were also observed in the stomach or gut of the reef fishes, but they were not too abundant in terms of percentage by weight. Copepods dominated the zooplankton population, but as observed in the diet of the reef fishes they occurred less frequently in the diet and resented low percentage in terms of weight. Hence, the abundance of the natural zooplankton population was not correlated with the copepods in the diet of most fishes. In addition, other identified zooplankton groups overlying coral reef area were not in proportion with the recognized zooplanktonic organisms in the diet of fishes. Most of the zooplankton might be present in the water column but fish species

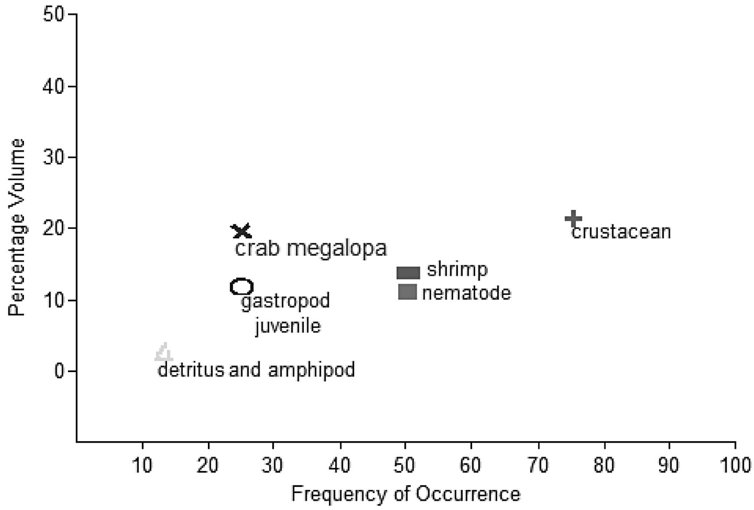

Fig. 7. Graphical representation of prey items in the gut of *Upeneus caeruleus* based on Costello's method.

Table 7. Classification of food habits of coral reef fishes

FISH SPECIES	TYPE OF FOOD HABIT	MAIN FOOD ITEMS
Gerres oyena	Zooplankton and benthic animal feeder	Crustacean fragments, mollusks
Leiognathus splendens	Zooplankton and benthic animal feeder	Crustacean fragments, copepod, mollusks
Lethrinus insulindicus	Zooplankton feeder	Fish juvenile, crustacean fragments
Scarus bowersi	Herbivores	Algae
Siganus guttatus	Herbivores	Algae
Siganus vermiculatus	Herbivores	Algae
Therapon jarbua	Zooplankton and benthic animal feeder	Fish juvenile, copepod, crustacean
Therapon sp.	Zooplankton and benthic animal feeder	Shrimp, mollusks copepod,
Upeneus caeruleus	Zooplankton and benthic animal feeder	Crustacean fragments, shrimp, nematode, detritus, crab megalopa

preferred to eat some and avoid others.

Availability of food supply in the environment is very important for fish. Like any organism, fishes require adequate nutrition in order to grow and survive. Through examination of the contents of digestive tracts and through physiological studies in the laboratory, researchers have learned much concerning feeding behavior, the kinds of organisms that are eaten, the mechanisms that have developed for digestion as well as the trophic relationships of fishes (Lagler, 1977). According to Bond (1979), trophic relationships of fishes are diverse and vary from sinple to complex depending upon the adaptations of the species involved. Fishes may occupy different levels of the food chain at different stages of their life histories, with most commencing to feed on small zooplankton organisms of similar size and later turning to definitive food. Some species may utilize a series of foods before attaining the adult stage. Fish culturists have learned through necessity what foods then are suitable for larval and juvenile fishes. Information on the food habits of the species is important to provide a better understanding on the trophic relationships of the fishes species.

This study can serve as a basis for the elaboration of plans for the integrated management of this ecosystem and the development of extensive culture programs of some species.

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